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***Cambarus (C.) hatfieldi*, a new species of crayfish (Decapoda:Cambaridae) from the Tug Fork River Basin of Kentucky, Virginia and West Virginia, USA**

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Abstract

Cambarus (Cambarus) hatfieldi is a stream-dwelling crayfish that appears to be endemic to the Tug Fork River system of West Virginia, Virginia, and Kentucky. Within this region, it is prevalent in all major tributaries in the basin as well as the Tug Fork River's mainstem. The new species is morphologically most similar to *Cambarus sciotensis* and *Cambarus angularis*. It can be differentiated from *C. sciotensis* by its squamous, subtringular chelae compared to the elongate triangular chelae of *C. sciotensis*; its shorter palm length/palm depth ratio (1.9) compared to *C. sciotensis* (2.3); and a smaller areola length/total carapace length ratio (30.4% vs. 36.5% respectively). *Cambarus hatfieldi* can be differentiated from *C. angularis* by its smaller areola length/total carapace length ratio (30.4% vs. 36.7% respectively); a smaller rostrum width/rostral length ratio (59.4% vs. 67.2% respectively); its rounded abdominal pleura as compared to the subtruncated pleura of *C. angularis*; the length of the central projection and mesial process of *C. hatfieldi* which both extend to the margin of the gonopod shaft or slightly beyond the margin compared to the central projection of *C. sciotensis* and *C. angularis* where both extend well beyond the margin of the gonopod shaft.

Key words: Crayfish, *Cambarus*, Kentucky, Virginia, West Virginia, Tug Fork River, Appalachian Mountains

Introduction

Cambarus sciotensis Rhoades, 1944, has one of the most disjunct ranges of any *Cambarus* species, with three geographically isolated populations (Jezerinac et al. 1995; Taylor and Shuster 2004) (Jezerinac et al. 1995; Taylor and Shuster 2004). The type population occurs in the Scioto River basin in Dublin Ohio, and shares morphological characters with populations in central and southern Ohio. *Cambarus sciotensis* also occurs upstream of Kanawha Falls in the New River system of West Virginia and Virginia; throughout the New River basin, *C. sciotensis* is the dominant large *Cambarus* species. *Cambarus sciotensis* is replaced in the Ohio River mainstem between the Scioto and eastern Kentucky populations and New River populations in the Big Sandy and Kanawha River system of West Virginia by *Cambarus robustus* Girard, 1852. The third population occurs in the Tug Fork River system of Kentucky, Virginia, and West Virginia.

The distribution of *C. sciotensis* in southwestern West Virginia and eastern Kentucky has long been inadequately documented (Jezerinac et al. 1995; Z. J. Loughman personal obs.). Jezerinac et al. (1995) documented *C. sciotensis* sporadically occurring throughout several watersheds in southwestern West Virginia outside of the New River basin. Recently, ZJL and SAW initiated a statewide survey of crayfishes in West Virginia, with special attention towards determining the ranges of *C. robustus* and *C. sciotensis*. Populations present outside of the New River in West Virginia's Guyandotte River basin of West Virginia, and the Big Sandy River basin of West Virginia and Kentucky excluding the Tug Fork River system of West Virginia and Kentucky were found to be an undescribed species since described as *Cambarus theepiensis* (Loughman et al. 2013).

morphological characters (Z. J. Loughman and R. F. Thoma personal observation). Given morphologic and zoogeographic differences, further taxonomic investigation is warranted between the Scioto and New River populations of *C. sciotensis*.

Etymology. Latinized form of Hatfield in honor of the Hatfield and M^cCoy feud which occurred in the Tug Fork River Valley of Kentucky and West Virginia in the 1860s–1870s.

Common name. Tug Valley Crayfish.

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References

- Cooper, J.E. (2006) A new species of crayfish of the genus *Cambarus* Erichson 1846 (Decapoda:Cambaridae) from the eastern Blue Ridge Foothills and Western Piedmont Plateau of North Carolina. *Proceedings of the Biological Society of Washington*, 119, 67–80.
[http://dx.doi.org/10.2988/0006-324x\(2006\)119\[67:ansoco\]2.0.co;2](http://dx.doi.org/10.2988/0006-324x(2006)119[67:ansoco]2.0.co;2)
- Faxon, W. (1884) Description of new species of *Cambarus*; to which is added a synonymical list of the known species of *Cambarus* and *Astacus*. *Proceedings of the American Academy of Arts and Sciences*, 20, 107–158.
<http://dx.doi.org/10.2307/25138768>
- Faxon, W. (1914) Notes on the crayfishes in the United States National Museum and the Museum of Comparative Zoology with descriptions of new species and subspecies to which is appended a catalogue of the known species and subspecies. *Memoirs of the Museum of Comparative Zoology, Harvard College*, 40, 351–427.
<http://dx.doi.org/10.5962/bhl.title.13326>
- Folmer, O., Black, M., Hoeh, W., Lutz, R. & Vrijenhoek, R. (1994) DNA primers for amplification of mitochondrial cytochrome *c* oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology*, 3, 294–295.
- Girard, C. (1852) A revision of the North American Astaci, with observations on their habits and geographic distribution. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 6, 87–91.
<http://dx.doi.org/10.1163/156854067x00530>
- Hay, W.P. (1902) Observations on the crustacean fauna of Nickajack Cave, Tennessee, and vicinity. *Proceedings of the United States National Museum*, 25, 417–439.
<http://dx.doi.org/10.5479/si.00963801.25-1292.417>
- Hobbs, H.H. Jr. (1969) On the distribution and phylogeny of the crayfish genus *Cambarus*. In: Holt, P.C. & Hoffman, R.L. (Eds.), *The Distributional History of the Biota of the Southern Appalachians. Part I: Invertebrates. Research Division Monograph 1*. Virginia Polytechnic Institution, Blacksburg, Virginia, pp. 93–178.
- Hobbs, H.H. Jr. & Bouchard, R.W. (1994) *Cambarus* (*Cambarus*) *angularis*, a new crayfish (Decapoda:Cambaridae) from the Tennessee River basin of northeastern Tennessee and Virginia. *Jeffersoniana*, 5, 1–13.
- Jezerinac, R.F. (1993) A new subgenus and new species of crayfish (Decapoda: Cambaridae) of the genus *Cambarus* with an amended description of the subgenus *Lacunecambarus*. *Proceedings of the Biological Society of Washington*, 106, 532–544.
- Jezerinac, R.F., Stocker, G.W. & Tarter, D.C. (1995) The crayfishes (Decapoda: Cambaridae) of West Virginia. *Bulletin of the Ohio Biological Survey*, 10, 1–193.
<http://dx.doi.org/10.1163/193724097x00205>
- Loughman, Z.J., Simon, T.P. & Welsh, S.A. (2009) West Virginia crayfishes (Decapoda: Cambaridae): observations on distribution, natural history, and conservation. *Northeastern Naturalist*, 16, 225–238.
<http://dx.doi.org/10.1656/045.016.0205>

- Loughman, Z.J., Foltz, D.A., Garrison, N.L. & Welsh, S.A. (2013) *Cambarus (P.) theepiensis*, a new species of crayfish (Decapoda:Cambaridae) from the coalfields region of eastern Kentucky and southwestern West Virginia, USA. *Zootaxa*, 3641 (1), 63–73.
<http://dx.doi.org/10.11646/zootaxa.3641.1.7>
- Masters, L. (1991) Assessing threats and setting priorities in conservation. *Conservation Biology*, 5 (4), 559–563.
<http://dx.doi.org/10.1111/j.1523-1739.1991.tb00370.x>
- Pond, G.J., Passmore, M.E., Borsuk, F.A., Reynolds, L. & Rose, C.J. (2008) Downstream effects of mountaintop coal mining: comparing biological conditions using family- and genus-level macroinvertebrate bioassessment tools. *Journal of the North American Benthological Society*, 27, 717–737.
<http://dx.doi.org/10.1899/08-015.1>
- Rhoades, R. (1944) Further studies on distribution and taxonomy of Ohio crayfishes, and the description of a new subspecies. *Ohio Journal of Science*, 44, 96–99.
- Taylor, C.A. (2000) Systematic studies of the *Orconectes juvenilis* complex (Decapoda: Cambaridae), with descriptions of two new species. *Journal of Crustacean Biology*, 20, 132–152.
<http://dx.doi.org/10.1163/20021975-99990023>
- Taylor, C.A. & Schuster, G.A. (2004) Crayfishes of Kentucky. *Illinois Natural History Survey Bulletin*, 28, 1–219.
<http://dx.doi.org/10.1353/shb.0.0166>
- Taylor, C.A., Schuster, G.A., Cooper, J.E., Distefano, R.J., Eversole, A.G., Hamr, P., Hobbs, H.H.III, Robison, H.W., Skelton, C.E. & Thoma, R.F. (2007) Reassessment of the conservation status of crayfishes of the United States and Canada after 10+ years of increased awareness. *Fisheries*, 32, 372–389.
[http://dx.doi.org/10.1577/1548-8446\(2007\)32\[372:arotcs\]2.0.co;2](http://dx.doi.org/10.1577/1548-8446(2007)32[372:arotcs]2.0.co;2)
- Thoma, R.F. (2010) The conservation status of *Cambarus (Puncticambarus) veteranus*, Big Sandy Crayfish and *Cambarus (Jugicambarus) parvovulus*, *Mountain Midget Crayfish in Kentucky*. MBI technical report to Kentucky Department of Natural Resources, 13 pp.